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PROBLEMS IN THE EXTRACTION OF ALUMINUM IN CHINATzu-jan K'o-hsueh, Vol I, No 4,
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[Summary: Hu Wei-po, of Pei-yang University, outlines the problems in extracting aluminum in China, and gives the general locations of the major deposits and the type and quality of ore. The author gives a brief background of the various processes for extracting aluminum, and proposes that a survey be made of all Kweichow and Yunnan ores. He recommends the Bayer or combination processes if the majority of these ores are of a high grade, and the ammonium sulfate method if they are mainly low-grade ores.]

In general, aluminum ore is found in Shantung, Liaotung, Yunnan, Kweichow, and Fukien. Judging by the known existing deposits, there are abundant reserves. However, exploratory drilling must continue to estimate accurately the quality and locations of these reserves.

The types of deposits are as follows: Northeast China and Shantung Province contain aluminum shale; Yunnan and Kweichow Provinces, bauxite; Szechwan Province, clay. The aluminum shale is mainly kaolinite and diaspore ($\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$). According to Professor Kerr of Columbia University, the Yunnan ore is boehmite, while Meng Hsien-min classifies it as diaspore, and Yu Shui-huang classifies it as diaspore and boehmite. The author has graded the Kweichow ore as kaolinite and diaspore. Hsieh Chia-yung classifies the Fukien ore as gibbsite ($\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$). Since the type of refining process depends upon the quality of the ore involved (for example, diaspore is not readily fusible in soda ash), much more research must be done in grading the deposits.

There are four areas containing ores suitable for the Bayer process (less than 5 percent SiO_2 , low iron content): Yun-lu-shan in Kweichow Province; Peichiang in Szechwan Province; Ts'ao-p'u in An-ning Hsien, Yunnan Province; and Ch'ih-hu-hsiang, Chang-p'u Hsien, Fukien Province. All other areas have low-grade aluminum ores with high silicon content. The percentage of SiO_2 and Fe_2O_3 in the ores are as follows: Shantung, 20-40 percent SiO_2 and 2-14 percent Fe_2O_3 ; Kweichow, 10-40 and 0.1-16 percent; and Northeast China, 15-30 and 14-15 percent, respectively.

One of the most difficult problems is deciding on the proper method to process these ores. In 1930, the Central Research Bureau investigated the alunite at P'ing-yang in Chekiang Province. However, considering the abundance of aluminum ores in Shantung, Yunnan, and Kweichow provinces, and in Northeast China, it is not necessary to use this low-grade ore for the extraction of aluminum, especially since it is used in the paper and leather industries. High-grade, low-silicon-content ores can be processed with the Bayer method and thus offer no problem.

In 1933, Chang Ch'eng-lung obtained good results using the soda ash fusion method to process Po-shan bauxite in Shantung Province. In 1942, Lung P'i-yen of the Ore Refining Research Laboratory, in experimenting with clay from Shantung, concluded that Goldschmidt's sulfate method was the best means of extracting aluminum from this ore.

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Wei Shou-k'un proposed that the new electrolysis method be tested in processing Kweichow Province's aluminum ore.

The Japanese have done much research on ores in Shantung Province. The Fu-shun Aluminum Plant began extracting aluminum in 1936 using an improved version of the Pederson method. This method was gradually developed until in 1940 a lime and soda ash fusion method was used. The Shantung Aluminum Plant was to use this method when it was rebuilt in 1940. The research done by the Japanese serves as an important source of reference in solving processing problems in Shantung.

During the past 10 years, research in processing ores of high silicon and iron content -- such as Shantung aluminum shale -- has led to two methods: the fusion method and the electrolysis method. The electrolysis method is more costly than the fusion method. The fusion method can also be divided into two types of processes: (1) the lime and soda ash fusion method, and (2) the lime fusion method (such as the Ancor method). According to the experiences of Soviet and American firms, the lime and soda ash fusion method is the cheapest method next to the Bayer process. Furthermore, the raw materials required in the lime and soda ash method (lime and sodium carbonate) can be easily produced domestically. Also, the equipment used is comparatively simple. Therefore, this method can be considered technically and economically superior for large-scale operations. Obviously, before this method can be put into operation, further research must be made on the proper proportions of raw materials (CaO with SiO_2 ; Na_2O with Al_2O_3), the temperature and length of time of the fusion, the viscosity and temperature of the molten alumina, and the control of the silicon and sodium carbonate.

An accurate evaluation should be made of the Kweichow and Yunnan ores, classifying the high-grade aluminum ores (low silicon and iron content, suitable for the Bayer process) and the low-grade ores (most of which are white or ivory colored bauxite with a high silicon and low iron content). If there is found to be a considerable quantity of high grade ore, consideration should be given to the Bayer process and the combination process. The combination process, developed in America, consists of mixing high- and low-grade ores, and applying both the Bayer process and the lime and soda ash process. The Soviet Union has a combination caustic alkali method in which the high- and low-grade ores are first processed separately using both the Bayer and the lime and soda ash methods. The resulting pure sodium aluminate from each process is then fused and processed again. This system allows for a wide range in the quality of raw materials.

If, through the ore surveys, it is found that most of the ore is of a low grade, then attention should be given to the acid processes (since SiO_2 does not dissolve in acids). The ammonium sulfate method is the most reliable, and the Goldschmidt method second. Some have suggested that the muriatic acid process be used, but Hoffman has concluded in his experiments that this process is far more costly than both the Bayer and the lime and soda ash processes. Moreover, at its present stage of development it offers no possibility for large-scale production.

Acid processes are not only expensive, but also very corrosive to the iron machinery. Acid-resistant materials -- such as stainless steel, ebonite, or lead -- are still in short supply. Acid processes require further development.

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